INTERMOUNTAIN STATION
Central Reference File
No. 3.4162
Ips Beetles

MISCELLANEOUS PAPER No. 33
REVISED MAY 1960

DIRECTIONS for using LINDANE SPRAYS to control IPS BEETLES in CALIFORNIA

by ROBERT L. LYON

PACIFIC SOUTHWEST
FOREST AND RANGE
EXPERIMENT STATION
BERKELEY - CALIFORNIA

FOREST SERVICE - U. S. DEPARTMENT OF AGRICULTURE

SUMMARY

WHAT TO USE AND HOW	For details see page
SPRAY MATERIALS ...a solution of lindane in diesel oil.....	1
MIXING THE SPRAY ...mix thoroughly; 0.2 percent solution by weight.....	2
INSECTICIDE SPRAYER ...use portable, general utility sprayer; 3- to 5-gallon capacity....	4
SPRAY NOZZLE ...use nozzle that produces a coarse cone-shaped spray rather than a mist.	5
PREPARATION OF INFESTED MATERIAL ...trees need to be felled (that's all); slash needs no special preparation..	5
SPRAY APPLICATION ...hold nozzle 1 to 1½ feet from bark; apply spray to point of wetness, not runoff.....	5
TIMING OF SPRAY ...apply spray not more than 1 week before adult beetles begin to emerge.....	6
SAFETY PRECAUTIONS ...lindane is toxic if swallowed or absorbed; read and heed the label...	6
OTHER POINTS TO REMEMBER	
EVALUATION OF CONTROL ...ask for help from an experienced appraiser.....	7
LINDANE FOR OTHER BARK BEETLES ...shows promise against Dendroctonus, at 1.5 percent concentration.....	7
LINDANE AS A PROTECTIVE SPRAY ...may prevent attacks on slash, saw-logs, and standing green trees.....	8

DIRECTIONS FOR USING LINDANE SPRAYS TO CONTROL IPS BEETLES IN CALIFORNIA

By Robert L. Lyon
Division of Forest Insect Research

Directions for controlling ips beetles with lindane were issued by the Experiment Station soon after this material showed promise as a residual spray. 1/ Experience since then has shown a need for changes; these are contained in this paper.

SPRAY MATERIALS

The spray to use is a solution of lindane in diesel oil. Lindane is sold either in pure form (99 percent or better) or as an ingredient in the compound benzene hexachloride (BHC). BHC is a mixture of chemicals, one of which is lindane.

The lindane content of BHC is variable: generally between 10 and 30 percent by weight. The amount of lindane in the BHC you buy must be known exactly because the lindane fraction is the only part toxic to insects and is the only part that needs to be considered when mixing a spray. The amount of lindane in any sample of BHC is clearly marked on the label and is always referred to as "gamma isomer" not "lindane."

The materials needed to formulate the spray are diesel oil and the insecticide either as lindane or as BHC. Kerosene may be used in place of diesel oil but is more expensive.

Lindane or BHC may be purchased in several different forms:

1. Solution concentrate--the insecticide dissolved in an oil solvent with nothing else added.

2. Technical product--the dry, powdered insecticide with nothing added.

3. Emulsion concentrate--the insecticide dissolved in an oil solvent along with an emulsifier which makes the concentrate mix readily with water.

4. Wettable powder--the insecticide mixed with an inert powder and a wetting agent which permits the wettable powder to be dispersed or suspended in water.

1/ Lyon, Robert L. Directions for using lindane sprays to control pine engravers. Pacific Southwest Forest and Range Expt. Sta. Misc. Paper No. 33, 5 pp., April 1959.

5. Dust--the insecticide mixed with or absorbed on an inert powder.

The solution concentrate (preparation 1) is the most suitable form. It is recommended above all other preparations.

The technical product (preparation 2) can be used but is less convenient because it does not mix well with diesel oil. Lindane is about three times more expensive when sold as "lindane" than when sold as "gamma isomer" of BHC, so it is cheaper to get BHC where you intend to purchase the ingredients separately and mix them yourself.

The emulsion concentrate (preparation 3) is not recommended but can be used if it is a brand that will dissolve in diesel oil. The emulsion concentrate is made to be mixed with water, not oil. So it often disperses in oil only in the form of discrete droplets. The stability of these "homogenates" varies. Some settle out rapidly on standing, especially at low temperatures. And they may undergo physical and chemical changes that make it impossible to redisperse them.

Wettable powders or dusts (preparations 4 and 5) are not suitable. Both of these materials contain inert powders which will not dissolve in oil, but will leave a sludge that can plug up spray equipment and cause much inconvenience.

Some California sources of lindane and BHC are:

California Spray-Chemical Corp.--Fresno, Richmond, Sacramento, San Jose, and Whittier.

Niagara Chemical Division, Food Machinery and Chemical Corp.--Richmond.

Stauffer Chemical Co.--Berkeley, Los Angeles, and San Francisco.

MIXING THE SPRAY

The finished spray must be a 0.2 percent solution of lindane (as lindane or as gamma isomer of BHC). This means that each 100 pounds of mixed spray contains 0.2 pound of lindane (or 1 part of lindane in 500 parts diesel oil by weight).

The amount of material to use in making a spray mixture of the proper concentration depends upon the form in which the lindane is obtained.

If you use the dry technical insecticide, the correct amounts to add to one gallon of diesel oil for a 0.2 percent lindane spray are--

Compound Percent gamma isomer		Weight in grams (28 grams = 1 ounce)
Lindane	100	6
BHC	30	21
BHC	25	25
BHC	20	31
BHC	17	36
BHC	15	41
BHC	12	51
BHC	10	62

When oil solution concentrates are used, it is easier to measure the amounts of concentrate and diesel oil in parts by volume. When the weight of insecticide in the concentrate is known, the following formula can be used to find the correct proportions for a finished spray:

$$\left[\frac{\left(\frac{A}{B}\right) - A}{6.8}\right] - 1 = \text{parts of diesel oil to one part of concentrate by volume.}$$

A = pounds of lindane (or gamma isomer) in one gallon of concentrate.

B = percent solution wanted (expressed as a proportion of 1).

Here is a frequently used example, where A = 1.7 pounds and B = 0.2 percent (0.002 when expressed as a proportion of 1).

$$\left[\frac{\left(\frac{1.7}{0.002}\right) - 1.7}{6.8}\right] - 1 = 124 \text{ parts (quarts, gallons, etc.)}$$

The correctness of your answer can be checked by the following calculation:

$$\frac{A}{6.8 \times \text{answer}} = \frac{1.7}{6.8 \times 124} = \frac{1.7}{843.2} = 0.002 \text{ or } 0.2 \text{ percent}$$

When the amount of insecticide in the concentrate is shown only as a percent of total weight, the ratio of ingredients to make a finished lindane spray can be determined by the following formula (but the formula using actual weight is more accurate):

$\frac{A}{B} \times 1.2$ = parts of diesel oil to one part of concentrate by volume.

A = percent of lindane (or gamma isomer) in concentrate.

B = percent solution wanted.

An example where A = 20 percent and B = 0.2 percent is:

$$\frac{0.20}{0.002} \times 1.2 = 120 \text{ parts (quarts, gallons, etc.)}$$

$\frac{.20}{.015} \times 1.2 = 16$

It is most convenient to use the solution concentrate. You can mix this with diesel oil when and in the amount needed, or you can contract to have the mixed spray supplied by a private formulator.

The need for thorough blending of concentrate and diesel oil cannot be overemphasized. Improper mixing will seriously impair the effectiveness of the spray. Some concentrates mix well, others do not. It is important to learn beforehand how well the brand of concentrate mixes with diesel oil before you decide on a purchase. It is also important to know that once mixed, the concentrate will stay mixed and will not settle out on standing.

Temperature will affect mixing properties. Low temperatures, sometimes encountered in the field, may strongly influence the ease with which blending can be done and the tendency of the insecticide to settle out or precipitate. Mixing can be done in the sprayer if the ingredients are freely miscible and do not settle out on standing.

INSECTICIDE SPRAYER

Use a portable, general utility or garden sprayer of about a 3- to 5-gallon capacity. Some suppliers are: Dobbins, Hudson, Indian, and Lofstrand. Be sure the sprayer can be used with oil solutions. Two types of sprayers are suitable for the job: (1) the compressed-air or compression sprayer and (2) the knapsack sprayer. The type you use depends on individual taste.

The compression sprayer is cylindrical and can be slung over one shoulder. It must be set down for repumping each time the air pressure in the tank is exhausted. The compression sprayer performs best if the tank is filled with spray to only 2/3 or 3/4 of capacity so that spraying time can be extended under a given head of air pressure. Some models can be equipped with refillable carbon dioxide cylinders. One fill can expel from 3 to 5 tankfuls of spray.

The knapsack sprayer is designed to be carried on the back, with adjustable straps to fit the individual operator. It is pumped continuously as you spray; there is no reservoir of compressed air as with the compression sprayer. The pump handle is brought forward so that it can be actuated while the sprayer is slung on the back. Some models permit the pump

handle to be placed on either side of the tank for right- or left-handed operation. The sprayer is also equipped with an agitator which continuously mixes the spray as you pump.

It is important to use a good sprayer and get high-quality leak-proof performance. A poor sprayer is a hazard to the operator and cannot be depended upon to give the consistently good performance needed for proper application of residual sprays.

SPRAY NOZZLE

Use a nozzle that produces a cone-shaped spray. To avoid drift, the nozzle should produce a coarse spray, not a mist. A nozzle orifice 1/32 inch in diameter is a good working size.

Many sprayers are fitted with nozzles that can be adjusted for fineness of spray and spray shape or pattern, or have a conventional nozzle with accessory nozzle disks for producing the different spray emission characteristics.

PREPARATION OF INFESTED MATERIAL

Slash, whether scattered or in piles, may be sprayed without special preparation, except that interfering limbs from larger pieces may need to be cut to allow the applicator ready access for spraying.

Infested trees will normally need to be felled. Limbing is necessary only to the extent that limbs hamper the work. Limbs that hold the tree off the ground help get a good coverage of spray and should be left on.

SPRAY APPLICATION

Accurate, uniform application is most important to the success of the control effort. Take care to apply the spray uniformly to all the bark surface to the point of bark wetness only. Application to runoff is wasteful and unnecessary. Hold the nozzle between 1 and 1-1/2 feet from the bark while applying the spray.

The amount of spray that will be needed for trees of different size is shown below. These are average figures but they should provide an adequate guide to spray needs. The figures represent total spray requirements. Between 25 and 50 percent of the total is lost through drift and other causes.

Tree d.b.h.	Total bark surface area	Volume of spray		
(Inches)	(Square ft.)	(Gallons)	(Quarts)	(Pints)
4	20	-	-	1
6	39	-	1	0
8	62	-	1	1
10	90	-	2	1½
12	126	-	3	½
18	235	1	2	0
24	345	2	0	1½
30	431	2	3	0
36	565	3	2	½

Spraying may proceed even though the bark is wet from rain, but not while it is raining or if the bark is so saturated that free water lies on the surface.

TIMING OF SPRAY AND RESIDUAL TOXICITY

For best results, the spray should be applied within a week before the adult beetles begin to emerge. Some reduction in potency will be sacrificed if the spray is applied much earlier than this.

The toxic life of lindane varies considerably depending especially on conditions in the field. Generally, the lindane deposit will begin to decline in toxicity probably in 1 to 3 weeks after being applied.

Lindane is not dissolved by water, so precipitation should not affect its toxicity except under conditions of heavy or prolonged rainfall, when water may erode the deposit away.

SAFETY PRECAUTIONS

The insecticide concentrate and the mixed spray are toxic to man when swallowed or absorbed through the skin. Both lindane and diesel oil can cause skin rashes to those sensitive to these compounds. Take these precautions:

1. Avoid contact with the spray. Stand to the windward while spraying.
2. Wash with soap and water when insecticide is spilled on the skin.
3. After spraying for several hours, bathe thoroughly, and launder clothes before using them again.
4. Destroy or bury empty insecticide containers.

The antidote for poisoning is given on the insecticide label. Instructions on the insecticide label should be carefully heeded.

EVALUATION OF CONTROL

The effectiveness of a chemical control effort is usually judged by the trend of the outbreak or the level of insect damage after spraying. An end to tree mortality is usually taken to mean that control was successful. On the other hand, continued tree mortality above economically tolerable levels is evidence that the control effort failed.

To single out the cause of failure is a difficult matter. Perhaps the spray used was not effective, detection of infested trees was not sufficiently complete, timing of the spray operation was not within acceptable limits, or formulation or application methods were inappropriate.

The effectiveness of the insecticide itself may be judged only by an experienced technician who can take appropriate samples of treated and untreated material to the laboratory for analysis. Even this is by no means conclusive, though such an analysis should indicate whether the insecticide spray was or was not the cause of control failure.

Furthermore, it is important to remember that an insecticide spray is only as good as the conduct of the whole control effort. No chemical control can be assured of working without skilled attention to all parts of the control program. The judgement of an experienced technician is needed in the application of chemical control, and each insect problem must be judged separately as to the need for and potential workability of a chemical control effort.

Field observations of beetle emergence from sprayed material have no meaning in the interpretation of the effectiveness of the insecticide. Holes chewed through the bark by emerging adults cannot be used to indicate how good a residual spray was. Lindane is a slow-acting insecticide which generally does not kill until 1 to 3 days after the beetles emerge, and the beetle contacts the insecticide only as it bores out and flies away.

LINDANE FOR OTHER BARK BEETLES

The effectiveness of lindane for controlling western bark beetles other than ips is not known. Preliminary research shows that lindane sprays may be effective on the western pine beetle (Dendroctonus brevicomis Lec.) and the mountain pine beetle (Dendroctonus monticolae Hopk.) if applied as a 1.5 instead of 0.2 percent solution. Field trials so far conducted on Dendroctonus beetles with a 1.5 percent solution also show that lindane holds considerable promise.

LINDANE AS A PROTECTIVE SPRAY

Lindane also promises to be useful in California in preventing bark-beetle attacks on slash, sawlogs, and standing trees. Though we have little experimental evidence to show that it works, we feel it merits a trial in the absence of other protective measures.

The spray formula to use can only be estimated because there is no experimental data to go by. A 0.2 to 0.5 percent solution should be effective. Again, the spray should be applied until the bark is just wet. With green standing trees, care should be taken to avoid getting spray on the foliage. The foliage can be burned by the spray and can be killed by heavy doses.

Before a protective spray is applied, examine the tree closely to make sure that beetles have not already attacked it. Trees cannot be protected once they have become infested. The foliage of a pine tree infested with bark beetles goes through various color phases--from a straw color to a reddish brown. When the foliage becomes straw colored, the tree is dead and cannot be saved by a protective spray. Even when green, the tree is beyond protection if infested with early stages of bark beetles.

Added protection of living trees can be had by applying repeat sprays every 4 to 6 months as long as bark-beetle-killed trees continue to show up near the trees to be protected. Slash and sawlogs cut in late spring or summer may need only one spraying to keep them from becoming infested because they will probably dry out and become unattractive to bark beetles before the protective effects of the spray are lost. This may not be true of slash or sawlogs cut in the fall since drying does not proceed as rapidly during the winter months; by spring of the next year, the protective effects of the lindane may have worn off, and beetles may still be attracted to the material.

> CAUTION: Lindane is a poison. Read carefully all directions on the container. The mixture of lindane and diesel oil recommended has the flammability of diesel oil alone and must be handled with the same precautions taken to avoid fires with diesel oil.

Mention of companies or products in this paper does not imply endorsement of these items nor disapproval of similar items not mentioned.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
PACIFIC SOUTHWEST
FOREST AND RANGE EXPERIMENT STATION
POST OFFICE BOX 245
BERKELEY 1, CALIFORNIA

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U. S. DEPARTMENT OF AGRICULTURE

BOISE RESEARCH CENTER 5 01
316 EAST MYRTLE STREET
BOISE IDAHO